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Jameco Part Number 214568

# MMBT2369LT1, MMBT2369ALT1

**MMBT2369ALT1 is a Preferred Device**

# Switching Transistors

## NPN Silicon

ON Semiconductor®

http://onsemi.com

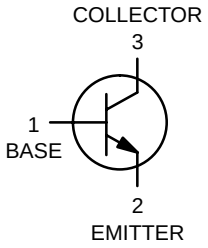
### MAXIMUM RATINGS

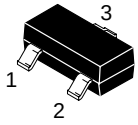
| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Collector–Emitter Voltage | $V_{CEO}$ | 15 | Vdc |
| Collector–Emitter Voltage | $V_{CES}$ | 40 | Vdc |
| Collector–Base Voltage | $V_{CBO}$ | 40 | Vdc |
| Emitter–Base Voltage | $V_{EBO}$ | 4.5 | Vdc |
| Collector Current – Continuous | $I_C$ | 200 | mAdc |

### THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|---|---|---|
| Total Device Dissipation FR–5 Board (Note 1) $T_A$ = 25°C<br>Derate above 25°C | $P_D$ | 225<br>1.8 | mW<br>mW/°C |
| Thermal Resistance, Junction to Ambient | $R_{\theta JA}$ | 556 | °C/W |
| Total Device Dissipation Alumina Substrate, (Note 2) $T_A$ = 25°C<br>Derate above 25°C | $P_D$ | 300<br>2.4 | mW<br>mW/°C |
| Thermal Resistance, Junction to Ambient | $R_{\theta JA}$ | 417 | °C/W |
| Junction and Storage Temperature | $T_J$, $T_{stg}$ | –55 to +150 | °C |

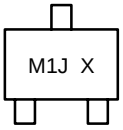
1. FR–5 = 1.0 × 0.75 × 0.062 in.
2. Alumina = 0.4 × 0.3 × 0.024 in. 99.5% alumina.



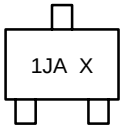




**SOT–23**
**CASE 318**
**STYLE 6**

### MARKING DIAGRAMS




MMBT2369LT1




MMBT2369ALT1

M1J, 1JA = Specific Device Code
X = Date Code

### ORDERING INFORMATION

| Device | Package | Shipping |
|---|---|---|
| MMBT2369LT1 | SOT–23 | 3000/Tape & Reel |
| MMBT2369ALT1 | SOT–23 | 3000/Tape & Reel |

**Preferred** devices are recommended choices for future use and best overall value.

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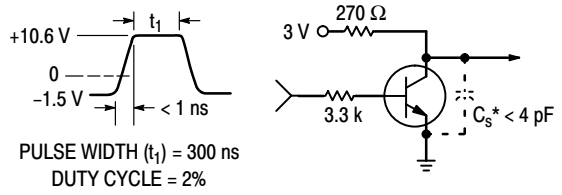
**ELECTRICAL CHARACTERISTICS** ($T_A$ = 25°C unless otherwise noted)

| Characteristic | | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | |
| Collector–Emitter Breakdown Voltage (Note 3)<br>($I_C$ = 10 mAdc, $I_B$ = 0) | | $V_{(BR)CEO}$ | 15 | – | – | Vdc |
| Collector–Emitter Breakdown Voltage<br>($I_C$ = 10 μAdc, $V_{BE}$ = 0) | | $V_{(BR)CES}$ | 40 | – | – | Vdc |
| Collector–Base Breakdown Voltage<br>($I_C$ = 10 μAdc, $I_E$ = 0) | | $V_{(BR)CBO}$ | 40 | – | – | Vdc |
| Emitter–Base Breakdown Voltage<br>($I_E$ = 10 μAdc, $I_C$ = 0) | | $V_{(BR)EBO}$ | 4.5 | – | – | Vdc |
| Collector Cutoff Current<br>($V_{CB}$ = 20 Vdc, $I_E$ = 0)<br>($V_{CB}$ = 20 Vdc, $I_E$ = 0, $T_A$ = 150°C) | | $I_{CBO}$ | –<br>– | –<br>– | 0.4<br>30 | μAdc |
| Collector Cutoff Current<br>($V_{CE}$ = 20 Vdc, $V_{BE}$ = 0) | MMBT2369A | $I_{CES}$ | – | – | 0.4 | μAdc |
| **ON CHARACTERISTICS** | | | | | | |
| DC Current Gain (Note 3)<br>($I_C$ = 10 mAdc, $V_{CE}$ = 1.0 Vdc)<br>($I_C$ = 10 mAdc, $V_{CE}$ = 1.0 Vdc)<br>($I_C$ = 10 mAdc, $V_{CE}$ = 0.35 Vdc)<br>($I_C$ = 10 mAdc, $V_{CE}$ = 0.35 Vdc, $T_A$ = –55°C)<br>($I_C$ = 30 mAdc, $V_{CE}$ = 0.4 Vdc)<br>($I_C$ = 100 mAdc, $V_{CE}$ = 2.0 Vdc)<br>($I_C$ = 100 mAdc, $V_{CE}$ = 1.0 Vdc) | <br>MMBT2369<br>MMBT2369A<br>MMBT2369A<br>MMBT2369A<br>MMBT2369A<br>MMBT2369A<br>MMBT2369<br>MMBT2369A | $h_{FE}$ | <br>40<br>–<br>40<br>20<br>30<br>20<br>20 | <br>–<br>–<br>–<br>–<br>–<br>–<br>– | <br>120<br>120<br>–<br>–<br>–<br>–<br>– | – |
| Collector–Emitter Saturation Voltage (Note 3)<br>($I_C$ = 10 mAdc, $I_B$ = 1.0 mAdc)<br>($I_C$ = 10 mAdc, $I_B$ = 1.0 mAdc)<br>($I_C$ = 10 mAdc, $I_B$ = 1.0 mAdc, $T_A$ = +125°C)<br>($I_C$ = 30 mAdc, $I_B$ = 3.0 mAdc)<br>($I_C$ = 100 mAdc, $I_B$ = 10 mAdc) | <br>MMBT2369<br>MMBT2369A<br>MMBT2369A<br>MMBT2369A<br>MMBT2369A | $V_{CE(sat)}$ | <br>–<br>–<br>–<br>–<br>– | <br>–<br>–<br>–<br>–<br>– | <br>0.25<br>0.20<br>0.30<br>0.25<br>0.50 | Vdc |
| Base–Emitter Saturation Voltage (Note 3)<br>($I_C$ = 10 mAdc, $I_B$ = 1.0 mAdc)<br>($I_C$ = 10 mAdc, $I_B$ = 1.0 mAdc, $T_A$ = –55°C)<br>($I_C$ = 30 mAdc, $I_B$ = 3.0 mAdc)<br>($I_C$ = 100 mAdc, $I_B$ = 10 mAdc) | <br>MMBT2369A<br>MMBT2369A<br>MMBT2369A<br>MMBT2369A | $V_{BE(sat)}$ | <br>0.7<br>–<br>–<br>– | <br>–<br>–<br>–<br>– | <br>0.85<br>1.02<br>1.15<br>1.60 | Vdc |
| **SMALL–SIGNAL CHARACTERISTICS** | | | | | | |
| Output Capacitance<br>($V_{CB}$ = 5.0 Vdc, $I_E$ = 0, f = 1.0 MHz) | | $C_{obo}$ | – | – | 4.0 | pF |
| Small Signal CurrentGain<br>($I_C$ = 10 mAdc, $V_{CE}$ = 10 Vdc, f = 100 MHz) | | $h_{fe}$ | 5.0 | – | – | – |
| **SWITCHING CHARACTERISTICS** | | | | | | |
| Storage Time<br>($I_{B1}$ = $I_{B2}$ = $I_C$ = 10 mAdc) | | $t_s$ | – | 5.0 | 13 | ns |
| Turn–On Time<br>($V_{CC}$ = 3.0 Vdc, $I_C$ = 10 mAdc, $I_{B1}$ = 3.0 mAdc) | | $t_{on}$ | – | 8.0 | 12 | ns |
| Turn–Off Time<br>($V_{CC}$ = 3.0 Vdc, $I_C$ = 10 mAdc, $I_{B1}$ = 3.0 mAdc, $I_{B2}$ = 1.5 mAdc) | | $t_{off}$ | – | 10 | 18 | ns |

3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

## SWITCHING TIME EQUIVALENT TEST CIRCUITS FOR 2N2369, 2N3227




*Total shunt capacitance of test jig and connectors.

**Figure 1. $t_{on}$ Circuit – 10 mA**

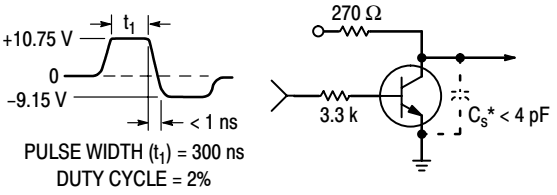
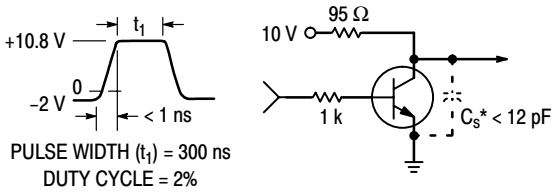



**Figure 3. $t_{off}$ Circuit – 10 mA**




*Total shunt capacitance of test jig and connectors.

**Figure 2. $t_{on}$ Circuit – 100 mA**

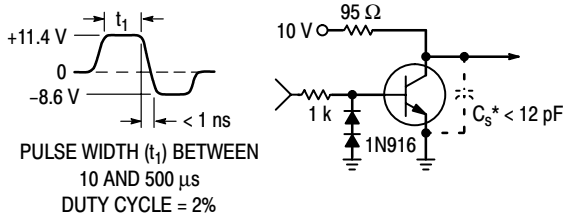



**Figure 4. $t_{off}$ Circuit – 100 mA**

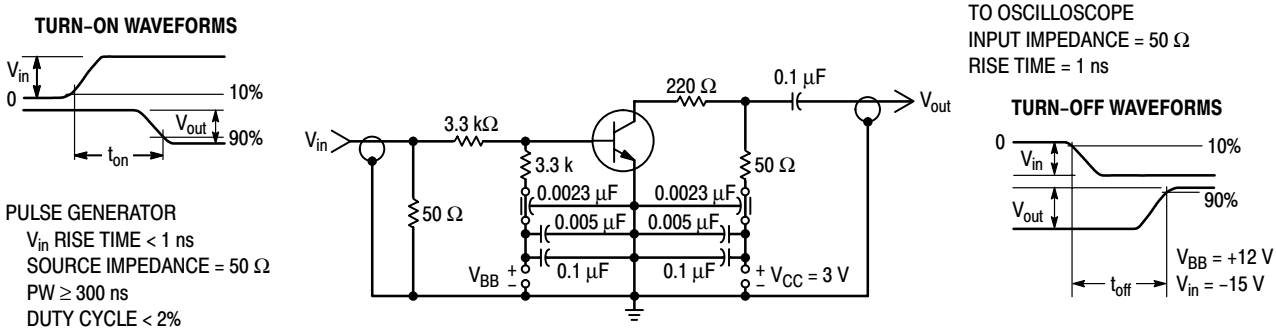



**Figure 5. Turn−On and Turn−Off Time Test Circuit**

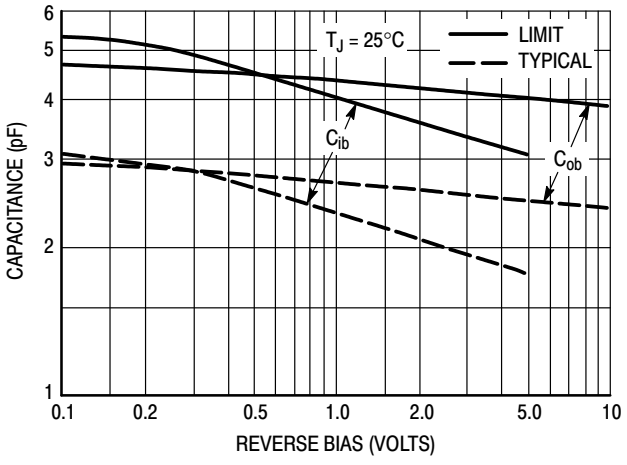



**Figure 6. Junction Capacitance Variations**

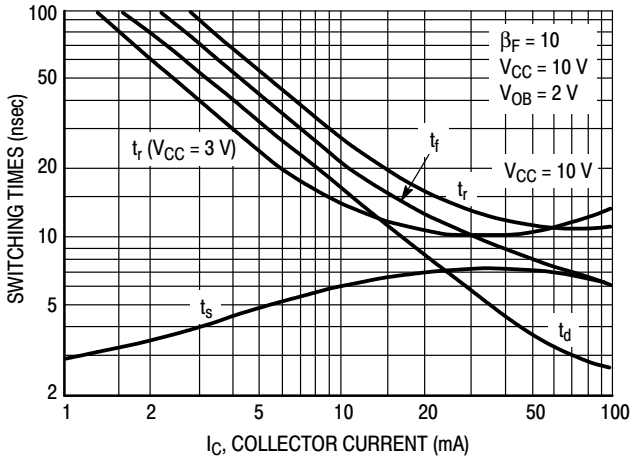



**Figure 7. Typical Switching Times**

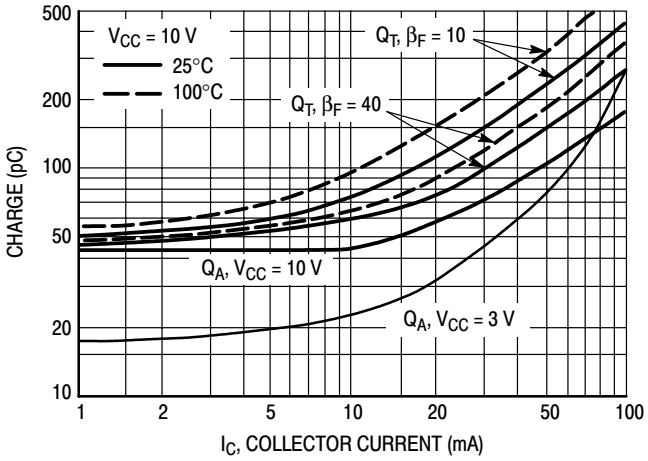



**Figure 8. Maximum Charge Data**

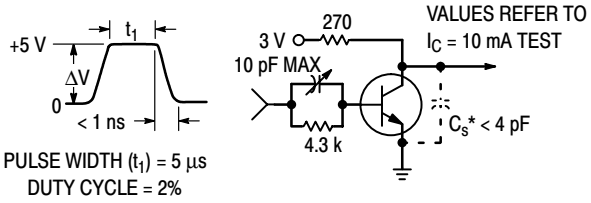



**Figure 9. $Q_T$ Test Circuit**

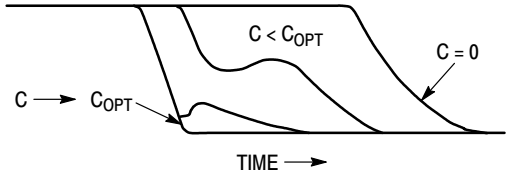



**Figure 10. Turn–Off Waveform**

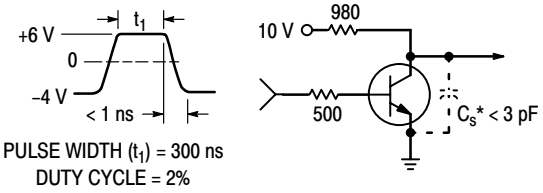



**Figure 11. Storage Time Equivalent Test Circuit**

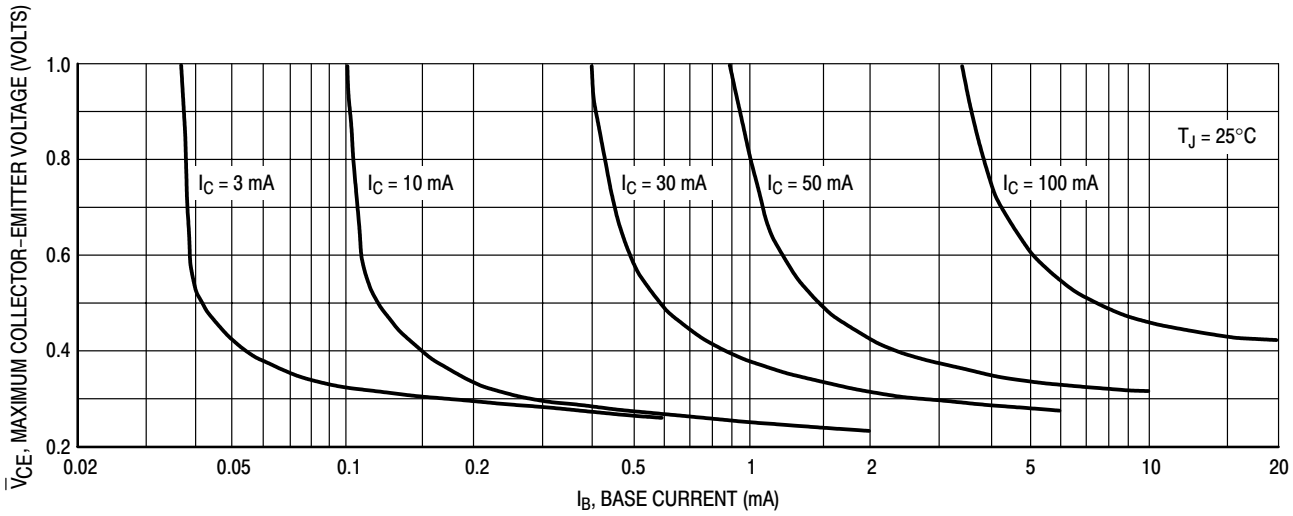



**Figure 12. Maximum Collector Saturation Voltage Characteristics**

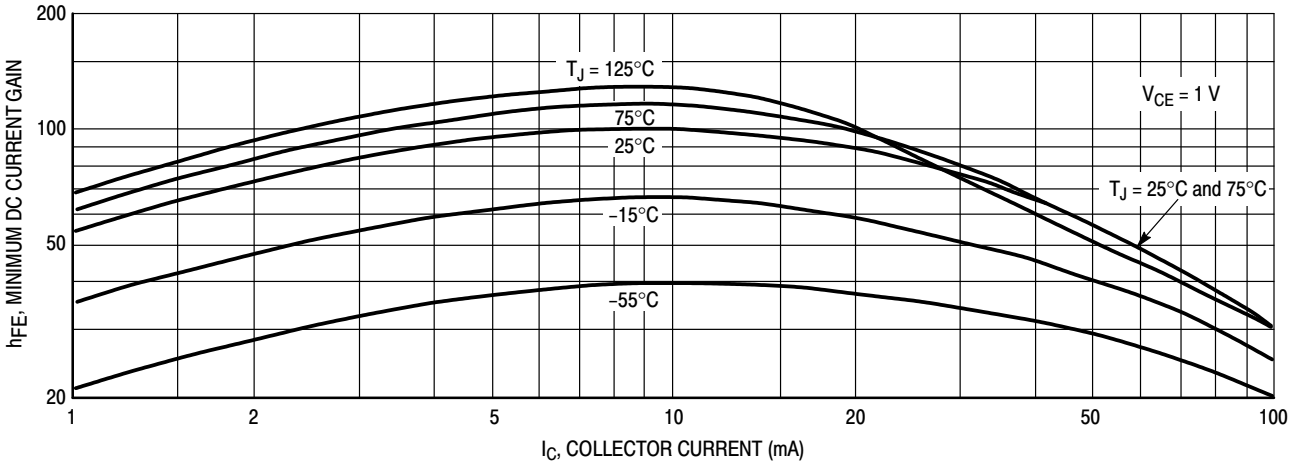



**Figure 13. Minimum Current Gain Characteristics**

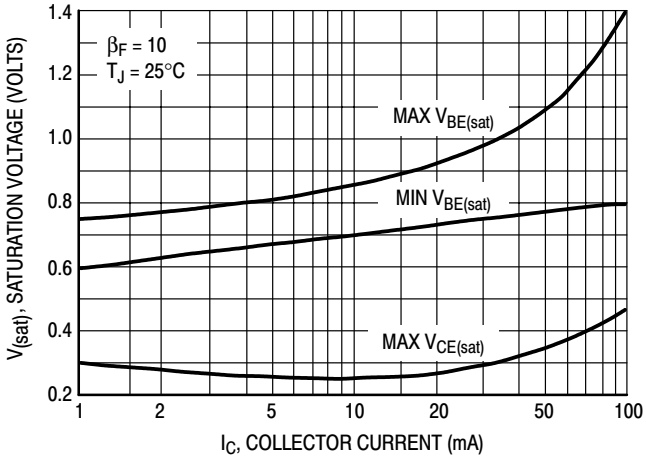



**Figure 14. Saturation Voltage Limits**

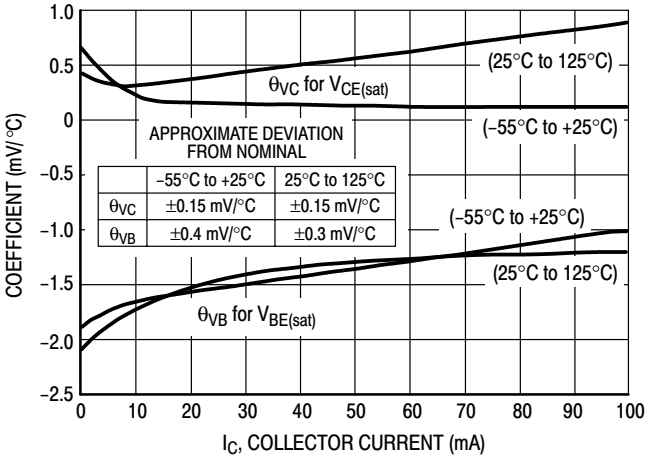
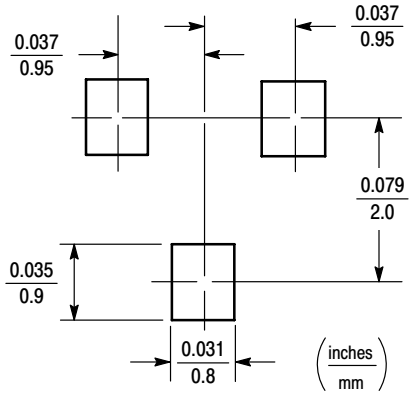



**Figure 15. Typical Temperature Coefficients**

# INFORMATION FOR USING THE SOT–23 SURFACE MOUNT PACKAGE

## MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS

Surface mount board layout is a critical portion of the total design. The footprint for the semiconductor packages must be the correct size to insure proper solder connection interface between the board and the package. With the correct pad geometry, the packages will self align when subjected to a solder reflow process.




**SOT–23**

## SOT–23 POWER DISSIPATION

The power dissipation of the SOT–23 is a function of the pad size. This can vary from the minimum pad size for soldering to a pad size given for maximum power dissipation. Power dissipation for a surface mount device is determined by $T_{J(max)}$, the maximum rated junction temperature of the die, $R_{\theta JA}$, the thermal resistance from the device junction to ambient, and the operating temperature, $T_A$. Using the values provided on the data sheet for the SOT–23 package, $P_D$ can be calculated as follows:

$$P_D = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

The values for the equation are found in the maximum ratings table on the data sheet. Substituting these values into the equation for an ambient temperature $T_A$ of 25°C, one can calculate the power dissipation of the device which in this case is 225 milliwatts.

$$P_D = \frac{150°C - 25°C}{556°C/W} = 225 \text{ milliwatts}$$

The 556°C/W for the SOT–23 package assumes the use of the recommended footprint on a glass epoxy printed circuit board to achieve a power dissipation of 225 milliwatts. There are other alternatives to achieving higher power dissipation from the SOT–23 package. Another alternative would be to use a ceramic substrate or an aluminum core board such as Thermal Clad®. Using a board material such as Thermal Clad, an aluminum core board, the power dissipation can be doubled using the same footprint.

### SOLDERING PRECAUTIONS

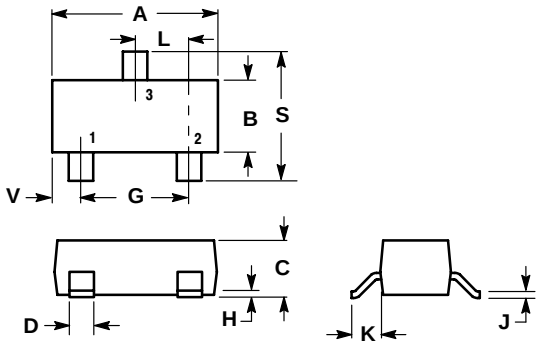
The melting temperature of solder is higher than the rated temperature of the device. When the entire device is heated to a high temperature, failure to complete soldering within a short time could result in device failure. Therefore, the following items should always be observed in order to minimize the thermal stress to which the devices are subjected.

- Always preheat the device.
- The delta temperature between the preheat and soldering should be 100°C or less.*
- When preheating and soldering, the temperature of the leads and the case must not exceed the maximum temperature ratings as shown on the data sheet. When using infrared heating with the reflow soldering method, the difference shall be a maximum of 10°C.
- The soldering temperature and time shall not exceed 260°C for more than 10 seconds.
- When shifting from preheating to soldering, the maximum temperature gradient shall be 5°C or less.
- After soldering has been completed, the device should be allowed to cool naturally for at least three minutes. Gradual cooling should be used as the use of forced cooling will increase the temperature gradient and result in latent failure due to mechanical stress.
- Mechanical stress or shock should not be applied during cooling.

* Soldering a device without preheating can cause excessive thermal shock and stress which can result in damage to the device.

## PACKAGE DIMENSIONS

**SOT–23 (TO–236)**
**CASE 318–08**
**ISSUE AH**




NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. 318–03 AND –07 OBSOLETE, NEW STANDARD 318–08.

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 0.1102 | 0.1197 | 2.80 | 3.04 |
| B | 0.0472 | 0.0551 | 1.20 | 1.40 |
| C | 0.0350 | 0.0440 | 0.89 | 1.11 |
| D | 0.0150 | 0.0200 | 0.37 | 0.50 |
| G | 0.0701 | 0.0807 | 1.78 | 2.04 |
| H | 0.0005 | 0.0040 | 0.013 | 0.100 |
| J | 0.0034 | 0.0070 | 0.085 | 0.177 |
| K | 0.0140 | 0.0285 | 0.35 | 0.69 |
| L | 0.0350 | 0.0401 | 0.89 | 1.02 |
| S | 0.0830 | 0.1039 | 2.10 | 2.64 |
| V | 0.0177 | 0.0236 | 0.45 | 0.60 |

STYLE 6:
PIN 1. BASE
2. EMITTER
3. COLLECTOR

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